Stanford

Tiziana Vanorio

Assistant Professor of Geophysics

Curriculum Vitae available Online

Bio

BIO

The mechanical and chemical interactions of fluids with earth materials drive many geological as well as engineered processes. My research focuses on studying the geophysical response of geomaterials to chemical reactions under stress, with particular emphasis on the physical and mechanical changes that result from rock-fluid interactions. Since this interaction has been traditionally treated as a purely poroelastic problem, my motivation is to create experiment-based rock physics models of velocity changes detected through time-lapse seismic monitoring. Through laboratory experiments and multi-scale imaging techniques, I study reactive processes under stress to identify changes in physical and mechanical properties of rocks and their response to Earth's conditions and processes. Specific applications of my research include the geophysical response of reservoirs and geological seals to fluid injection, shales and carbonates to diagenetic processes, and volcanic ash to natural and man-made cementation forming ash beds and ancient materials from pozzolanic activity and geopolymerization

ACADEMIC APPOINTMENTS

- Assistant Professor, Geophysics

ADMINISTRATIVE APPOINTMENTS

- Invited Professor, Center for Carbonate System and Reservoir Geology, Université de Provence Aix Marseille, France, (2010-2010)
- Senior Research Scientist, Geophysics Department, Stanford University, (2008-2013)
- Research Associate, Geophysics Department, Stanford University, (2005-2008)
- Marie Curie Research Fellow, UMR Géosciences Azur,, Université de Nice Sophia Antipolis, France, (2002-2005)
- Post-doctoral Researcher, Geophysics Department, Stanford University, (1999-2001)

HONORS AND AWARDS

- Alfred Wegener Award, European Association of Geoscientists and Engineers (2018)
- Editor's Choice "Printing Out The Pores", SCIENCE (2016)
- Cover of the journal SCIENCE "Concrete Connection", SCIENCE (2015)
- NSF CAREER Award, National Science Foundation (2015)
- Nominee to the Stanford "Great Teaching Showcase", Stanford's Year of Learning, Stanford University (2015)
- SPE Innovative Teaching Award, Society of Petroleum Engineering (2014)
- Editors' Citation for the Brightspots of Geophysics, Society of Exploration Geophysics (2011)
- Best Paper of SEG and E&P Forum, Society of Exploration Geophysics (2010)
- EURY program, ranked among the top 5 outstanding young researchers in France, European Science Foundation (2005)
- Marie Sk#odowska-Curie Fellow, European Community, Marie Curie Individual Fellowship (2002-2005)

- NATO Fellowship, Italian National Research Council (2000)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Member, Faculty Search Committee, Stanford University (2015 - present)
- Invited Seminar Speaker (Dec), USGS Pacific Region Colloquium, Menlo Park, CA (2016 - 2016)
- Invited Seminar Speaker (Nov), San Jose State University Geology Club (2016 - 2016)
- Keynote Speaker (Sept), 88th Congress Italian Geological Society, Naples, Italy (2016 - 2016)
- Invited Speaker (July), SEG-AGU Summer Workshop, Upper Crust Physics of Rocks, Hilo, Hawaii (2016 - 2016)
- Invited Speaker (April), EGU General Assembly, Vienna, Austria (2016 - 2016)
- Invited Speaker (March), PGS - Peninsula Geological Society (2016 - 2016)
- Invited Seminar Speaker, USGS, Menlo Park, USA (2015 - 2015)
- Invited Seminar Speaker, University of Pisa, Italy (2015 - 2015)
- Invited Seminar Speaker, University Joseph Fourier, Grenoble (2015 - 2015)
- Member, Outreach Committee, Stanford University (2015 - present)
- Member, Undergraduate Committee, Stanford University (2015 - 2015)
- Member, Admission Committee, Stanford University (2015 - 2015)
- Invited Seminar Speaker, Georgia Tech (2014 - 2014)
- Invited Speaker, Evolving Rock Structure: From Grain-Scale to Planet-Scale, Gordon Research Conference (2014 - 2014)
- Member, Advisory PhD Committees, Stanford University (2013 - present)
- Member, Teaching Task Force Committee, Stanford University (2013 - present)
- Keynote speaker, Advanced Carbonate Reservoir Characterization, SPE Applied Technology Workshop (2013 - 2013)
- Symposium Chair, Measuring, Imaging, and Computing to Probe Multi-scale Rock Processes, AGU Fall Meeting (2013 - 2013)
- Invited Speaker, New Developments in Carbonate Rock Physics Characterization, AAPG Geosciences Technology Workshop (2012 - 2012)
- SEG D&P Summer Forum Committee, “Are We Ready for Megatonne-Scale CO2 Sequestration and EOR?”, SEG (2010 - 2010)
- Chair and Organizer, EAGE Workshop, “Carbonate Rock Physics: the Good, the Bad, and the Unknown”, EAGE (2009 - 2009)
- Member, Space Committee, School of Earth Sciences, Stanford University (2009 - 2009)
- Convener, AGU Session, “Monitoring Techniques and Interpretation Methods for Coupled Thermo-Hydro-Mechanical Processes in the Earth Crust”, AGU (2008 - 2008)
- Member, Scientific Program Review Panel, Agence National de la Recherche, France (2008 - 2008)
- Session Chair and Technical Committee Member, SEG Summer Research Workshop, “Emergent and Challenging Issues in Rock Physics: Rock This House!” Galway, SEG (2008 - 2008)
- Member, Committee for the Best Student Award, AGU Fall Meeting, San Francisco, AGU (2007 - present)
- Member, Scientific Program Review Panel, DOE - BES (2007 - present)
- Member, Lab Consolidation Committee, Stanford University (2007 - 2008)
- Judge, School of Earth Science Research Review, Oral Presentation, School of Earth Science, Stanford University (2007 - 2007)
- Member, Scientific Program Review Panel, European Community, Marie Curie Program (2005 - present)

PROFESSIONAL EDUCATION

- Other, Habilitation à diriger des recherches and Qualification aux Fonctions de Professeur des Universités , Université de Nice Sophia Antipolis (France)
- Ph.D, University of Naples Federico II (Italy) , Geophysics and Volcanology,
- M.S. (Honors), University of Naples Federico II (Italy) , Geological Science

- B.S., University of Naples Federico II (Italy) , Geological Science

LINKS

- Faculty Profile: https://earth.stanford.edu/news/geophycist-grew-crater-literally
- Research Group Web Site: https://pangea.stanford.edu/researchgroups/srpl/

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Research

I study the effect of rock-fluid interactions on rock properties. When monitoring many geophysical processes—for example, fluid disposal or storage, thermal and chemical stimulation of reservoirs, or naturally occurring thermo-chemical processes—the likelihood of fluid-rock chemical interactions raises numerous concerns. Unpredicted rock alteration can cause leaks leading to ground and surface contamination, can undermine the efficacy of certain stimulation practices, and can lower the rock strength exposing the area to seismic activity. To prevent unexpected outcomes in these situations, we must address an important scientific question: how to geophysically characterize, with more accuracy than is currently available, the effect of rock-fluid interactions on rock properties?

My research focuses on deciphering the geophysical response of rock-fluid interactions. My group and I are using a sophisticated experimental approach that includes multi-physics, multi-scale imaging, and time-dependence to understand the effects on the observed geophysical parameters of the wide spectrum of changes that a rock experiences as a result of coupled thermo-chemo-mechanical processes.

Practical applications of my research include the geophysical characterization of the chemical and physical changes that a rock formation experiences upon the injection of fluids for the purpose of storage (i.e., CO2) and enhancement of the production of fossil energy (i.e., unconventional reservoirs and formation damage).

Teaching

My undergraduate teaching focuses on introducing students to the topic of energy and the challenges surrounding it so they can get prepared to become environmentally aware members of society. As part of this objective, I developed a new course, The Water-Energy Nexus. Students learn about the basic concepts of the conjoined management of the water and energy resources and gain a practical knowledge of how research is done. Under the instructor's guidance, the students choose a question of interest for a short, literature-based research project related to the course theme. At the graduate level, I offer classes and seminars on experimental rock physics (GP162- Laboratory Methods In Geophysics). The class combines theoretical lectures and hands-on demonstrations of laboratory procedures. Students learn the underpinning knowledge for experimental rock physics and develop laboratory skills –e.g., making deductions from measurements, familiarizing with apparatus and measurement techniques, acquiring critical awareness, bridging theory and practice.

To adapt knowledge and skills to the high-tech student’s lifestyle and inspire and engage the next generation of experimental scientists, I am leading a project that is designed to complement lectures on laboratory techniques and analytical methods with an online repository of visualized experiments. The repository is composed of interactive, 3-D animated renderings that show how to assemble and operate laboratory set-ups for conducting experiments, and measure rock properties that are central to the characterization of the Earth sub-surface.
The tools provide a virtual laboratory to facilitate teaching of introductory laboratory classes and expose students from other institutions to techniques that might be unavailable to them due to the lack of a rock-physics laboratory in their Geosciences. facilities.

PROJECTS

- Experimental Investigation For the Characterization of the Geophysical Response of Rock-Fluid Interactions (1/15/2015 - 12/31/2019)
- Evolution of the Elastic and Transport Properties of Barnett Shales Upon Natural and Induced Maturation

- A Repository of Visualized and Interactive Experiments in Geophysics - VPOL Seed Grant & SES Support
- Shale Rock Properties for Sweet Spot Identification: Measuring, Imaging, and Computing
- Advanced Technologies for Monitoring CO2 Saturation and Pore Pressure in Geologic Formations: linking the Chemical and Physical Effects to Elastic and Transport Properties.
- Linking Chemical and Physical Effects of CO2 injection to Geophysical Parameters

Teaching

COURSES

2019-20

- Experimental Rock Physics: GEOPHYS 385N (Aut, Win, Spr, Sum)
- Laboratory Characterization of Properties of Rocks and Geomaterials: CEE 192, GEOPHYS 162, GEOPHYS 259 (Spr)
- Sedimentology and Rock Physics of Carbonates: GEOLSCI 254, GEOPHYS 254 (Win)

2018-19

- Experimental Rock Physics: GEOPHYS 385N (Aut, Win, Spr, Sum)
- Laboratory Characterization of Properties of Rocks and Geomaterials: CEE 192, GEOPHYS 162, GEOPHYS 259 (Spr)

2017-18

- Experimental Rock Physics: GEOPHYS 385N (Aut, Win, Spr, Sum)
- Volcanoes, Roman Concrete and Archaeology: OSPGEN 15 (Sum)

2016-17

- Experimental Rock Physics: GEOPHYS 385N (Aut, Win, Spr, Sum)
- Laboratory Methods in Geophysics: GEOPHYS 162, GEOPHYS 259 (Aut)

STANFORD ADVISEES

Postdoctoral Faculty Sponsor

Jihui Ding, Saied Mighani

Doctoral Dissertation Advisor (AC)

Krongrath Suwannasri

Master's Program Advisor

Margariete Malenda

Doctoral (Program)

Jackson MacFarlane

Publications

PUBLICATIONS

- **IN PREPARATION - Estimation of Rock Properties From P- and S- wave Velocity Structures Through Deterministic Rock Physics Models** *JGR*
  Vanorio, T., Virieux, J., Latorre, D.
  2019
- **IN PREPARATION - Rock Phyiscs Characterization of Ash Beds in Shales Reservoirs** *GEOPHYSICS LETTERS*
  Vanorio, T., MacFarlane, J., Clark, A.
  2019

- **IN PREPARATION - Modeling Velocity Weakening Due to Decarbonation Reaction** *GEOPHYSICS*
  Head, D. A., Vanorio, T.
  2019

- **IN PREPARATION - The Role of Lime-Cemented Volcanic Ash on Permeability and Strength** *JGR*
  MacFarlane, J., Ledingham, G., Vanorio, T., Clark, A.
  2019

- **SUBMITTED- Estimating Micrite and Macroporosity Content in Carbonate Reservoir Rocks for Porosity-Permeability Analysis** *PETROPHYSICS*
  El Husseiny, A., Vanorio, T., Duranti, L., Playton, T.
  2018

- **SUBMITTED - Data-Driven Elastic Modeling Of Organic-Rich Marl During Maturation** *GEOPHYSICS*
  Suwannasri, K., Vanorio, T., Clark, A.
  2018

- **SUBMITTED - The Alchemies of Lime and Sulfur in Forming Concrete-Like Rocks in Calderas** *FRONTIERS EARTH-SCI*
  Vanorio, T., MacFarlane, J., Clark, A.
  2018

- **SUBMITTED - Dynamic Evolution of Permeability upon Micro-CT Imaged Chemo-Mechanical Compaction** *EPSL*
  Macente, A., Vanorio, T., Miller, K., Fusseis, F., Butler, I.
  2018

- **SUBMITTED - Ancient Concrete, Older Rocks: Engineered By Humans, Inspired by Nature?** *PNAS*
  MacFarlane , J., Vanorio, T., Monteiro, P.
  2018

- **Predicting porosity of binary mixtures made out of irregular nonspherical particles: Application to natural sediments** *ADVANCED POWDER TECHNOLOGY*
  El-Husseiny, A., Vanorio, T., Mavko, G.
  2019; 30 (8): 1558–66

- **A scale-consistent method for imaging porosity and micrite in dual-porosity carbonate rocks** *GEOPHYSICS*
  Miller, K., Vanorio, T., Yang, S., Xiao, X.
  2019; 84 (3): MR115–MR127

- **Monitoring The Changes In The Microstructure, Elastic And Transport Properties of Eagle Ford Marl Caused By Ex-Situ Maturation** *GEOPHYSICS*
  Suwannasri , K., Vanorio , T., Clark , A.
  2018; 83 (5): MR263-MR281

- **KG²B, a collaborative benchmarking exercise for estimating the permeability of the Grimsel granodiorite – Part 2: modeling, microstructures and complementary data** *GEOPHYS. J. IINT.*
  David, C., Wasserman, J., Amann, F., Klaver, J., Davy, C., Sarout, J., Esteban, L., Rutter, E., Hu, Q., Louis, L., Delage, P., Lockner, D., Selvadurai, et al
  2018; 214 (1)

- **KG²B, a collaborative benchmarking exercise for estimating the permeability of the Grimsel granodiorite – Part 1: measurements, pressure dependence and pore-fluid effects** *GEOPHYS. J. IINT.*
  David, C., Wassermann, J., Amman, F., Lockner , D., Rutter, E., Vanorio, T., Amann Hildenbrand , A., Billiotte , J., Reuschlé , T., Lasseux , D., Fortin, J., Lenormand, R., et al
  2018; 214 (1)

- **Imaging of local porosity and micrite distributions of carbonate rocks using data-constrained modeling** *GEOPHYSICS*
  Miller, K., Vanorio, T., Yang, S., Xiao, X.
  2018

- **Permeability of volcanic ash-lime mixtures during CO2-mediated Carbonation and Decompression** *JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH*
  Clark, A., MacFarlane, J., Vanorio, T.
  2018; 123

- **Elastic Softening of Limestone upon Decarbonation with Episodic CO2 Release** *JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH*
  Head, D., Vanorio, T., Clark, A.
  2018; 123: 7404–7420

- **Evolution of Permeability due to Rock-Fluid Interaction: Numerically Simulated and Experimentally Measured Dissolution** *JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH*
  Miller, K., Vanorio, T., Keem, Y.
  2017

- **The KG(2)B Project: A World-Wide Benchmark of Low Permeability Measurement**
  David, C., Wassermann, J., KG2B Team, Vandamme, M., Dangla, P., Pereira, J. M., Ghabezloo, S.
  AMER SOC CIVIL ENGINEERS.2017: 1153–61

- **Porosity-permeability relationship in dual-porosity carbonate analogs** *GEOPHYSICS*
  El Husseiny, A., Vanorio, T.
  2017; 82 (1): MR65-MR74

- **Can Rock Microstructures Exhibit An Auxetic Behavior?** *International Journal of Solids and Structures*,
  Wollner, U., Vanorio, T., Kiss, A.
  2017; 130-131: 211-219

- **Effects of changes in rock microstructures on permeability: 3-D printing investigation** *GEOPHYSICAL RESEARCH LETTERS*
  Head, D., Vanorio, T.
  2016; 43 (14): 7494-7502

- **On the evolution of the elastic properties of organic-rich shale upon pyrolysis-induced thermal maturation** *GEOPHYSICS*
  Allan, A. M., Clark, A. C., Vanorio, T., Kanitpanyacharoen, W., Wenk, H.
  2016; 81 (3): D263-D281

- **The rock physics and geochemistry of carbonates exposed to reactive brines** *JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH*
  Clark, A. C., Vanorio, T.
  2016; 121 (3): 1497-1513

- **Porosity-Permeability Relationship in Dual Porosity Carbonate Analogs** *GEOPHYSICS*
  El Husseiny, A., Vanorio, T.
  2016

- **Effects of changes in rock microstructures on permeability: 3-D printing investigation** *Geophysical Research Letters. Selected as Editor's Choice by the journal Science*
  Head, D., Vanorio, T.
  2016: 1-9

- **On the Evolution of the Elastic Properties of Organic-Rich Shale upon Pyrolysis-Induced Thermal Maturation** *GEOPHYSICS*
  Allan, A., Clark, A., Vanorio, T., Kanitpanyacharoen, J., Wenk, R.
  2016; 81 (3): D263 – D281

- **The rock physics and geochemistry of carbonates exposed to reactive brines** *JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH*
  Clark, A., Vanorio, T.
  2016; 121 (3)

- **Time-lapse characterization of hydrothermal seawater and microbial interactions with basaltic tephra at Surtsey Volcano** *SCIENTIFIC DRILLING*
  Jackson, M. D., Gudmundsson, M. T., Bach, W., Cappelletti, P., Coleman, N. J., Ivarsson, M., Jonasson, K., Jorgensen, S. L., Marteinsson, V., McPhie, J., Moore, J. G., Nielson, D., Rhodes, et al
  2015; 20: 51–58

- **Chemomechanical evolution of pore space in carbonate microstructures upon dissolution: Linking pore geometry to bulk elasticity** *JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH*
  Arson, C., Vanorio, T.
  2015; 120 (10): 6878-6894

- **ROCK PHYSICS Rock physics of fibrous rocks akin to Roman concrete explains uplifts at Campi Flegrei Caldera** *SCIENCE*
  Vanorio, T., Kanitpanyacharoen, W.
  2015; 349 (6248): 617-621

- **The effect of micrite content on the acoustic velocity of carbonate rocks** *GEOPHYSICS*
  El Husseiny, A., Vanorio, T.
  2015; 80 (4): L45-L55

- **A multiscale methodology for the analysis of velocity anisotropy in organic-rich shale** *GEOPHYSICS*
  Allan, A. M., Kanitpanyacharoen, W., Vanorio, T.
  2015; 80 (4): C73-C88

- **Recent advances in time-lapse, laboratory rock physics for the characterization and monitoring of fluid-rock interactions** *GEOPHYSICS*
  Vanorio, T.
  2015; 80 (2): WA49-WA59

- **What Laboratory-Induced Dissolution Tell us About Natural Diagenetic Trends of Carbonate Rocks** *in Agar, S. M. & Geiger, S. (eds), Fundamental Controls on Fluid Flow in Carbonates. GEOLOGICAL SOCIETY OF LONDON, Special Publications*
  Vanorio, T., Ebert, Y., Grombacher, D.
  2015; 406 (v.4): 311-329

- **Pyrolysis-induced P-wave velocity anisotropy in organic-rich shales** *GEOPHYSICS*
  Allan, A. M., Vanorio, T., Dahl, J. E.
  2014; 79 (2): D41-D53

- **Pressure effects caused by CO2 injection in the Snøhvit Field** *First Break*
  Grude, S., Dvorkin, J., Vanorio, T., Clark, A., Landro, M.
  2013; 31 (12)

- **Time-lapse acoustic, transport, and NMR measurements to characterize microstructural changes of carbonate rocks during injection of CO2-rich water** *GEOPHYSICS*
  Grombacher, D., Vanorio, T., Ebert, Y.
  2012; 77 (3): WA169-WA179

- **The Campi Flegrei Blind Test: evaluating the imaging capability of local earthquake tomography in a volcanic area** *International Journal of Geophysics*
  Priolo, E., et al
  2012: 1-37

- **Laboratory measurements of the acoustic and transport properties of carbonate rocks and their link with the amount of microcrystalline matrix** *GEOPHYSICS*
  Vanorio, T., Mavko, G.
  2011; 76 (4): E105-E115

- **Modeling of elasticity effects of sandstone compaction using coated inclusions** *GEOPHYSICS*
  Agersborg, R., Johansen, T. A., Mavko, G., Vanorio, T.
  2011; 76 (3): E69-E79

- **Laboratory measurements of elastic properties of carbonate rocks during injection of reactive CO2-saturated water** *GEOPHYSICAL RESEARCH LETTERS*
  Vialle, S., Vanorio, T.
  2011; 38

- **Rock Physics Analysis and Time-Lapse Imaging of Geochemical effects Due to the Injection of CO2 into Reservoir Rocks** *Geophysics and Highlighted in the Brightspots of Geophysics*
  Vanorio, T., Ebert, Y., Nur, A.
  2011; 76: 23-33

- **Laboratory measurements of porosity, permeability, resistivity, and velocity on Fontainebleau sandstones** *GEOPHYSICS*
  Gomez, C. T., Dvorkin, J., Vanorio, T.
  2010; 75 (6): E191-E204

- **Texture analysis of a turbostratically disordered Ca-montmorillonite** *AMERICAN MINERALOGIST*
  Lutterotti, L., Voltolini, M., Wenk, H., Bandyopadhyay, K., Vanorio, T.
  2010; 95 (1): 98-103
- **The Rock Physics Basis for 4D Seismic Monitoring of CO2 Fate: Are we there Yet?** *The Leading Edge*
  Vanorio, T., Mavko, G., Vialle, S., Spratt, K.
  2010; 29 (2)
- **Measuring and monitoring heavy-oil reservoir properties** *Geophysical Developments Series*
  Wolf, K., Vanorio, T., Mavko, G.
  2010; 27: 99-105
- **The influence of pore fluids and frequency on apparent effective stress behavior of seismic velocities** *GEOPHYSICS*
  Mavko, G., Vanorio, T.
  2010; 75 (1): N1-N7
- **Seismic images and rock properties of the very shallow structure of Campi Flegrei caldera (southern Italy)** *BULLETIN OF VOLCANOLOGY*
  Dello Iacono, D., Zollo, A., Vassallo, M., Vanorio, T., Judenherc, S.
  2009; 71 (3): 275-284
- **Confocal laser scanning and atomic-force microscopy in estimation of elastic properties of the organic-rich Bazhenov Formation Read More: https://library.seg.org/doi/10.1190/1.3064141** *The Leading Edge*
  Ahmadov, R., Vanorio, T., Mavko, G.
  2009; 28 (1)
- **Three-dimensional tomography and rock properties of the Larderello-Travale geothermal area, Italy** *PHYSICS OF THE EARTH AND PLANETARY INTERIORS*
  De Matteis, R., Vanorio, T., Zollo, A., Ciuffi, S., Fiordelisi, A., Spinelli, E.
  2008; 168 (1-2): 37-48
- **Emerging methodologies to characterize the rock physics properties of organic-rich shales** *The Leading Edge*
  Vanorio, T., Mukerji, T., Mavko, G.
  2008; 27 (6): 780-787
- **The Effect of Chemical Processes and Mineral Composition on the Acoustic Properties of Carbonate Rocks** *The Leading Edge*
  Vanorio, T., Scotellaro, C., Mavko, G.
  2008; 27 (8)
- **3-D Seismic Tomography from P- and S- Microearthquake Traveltimes and Rock Physics Characterization in the Campi Flegrei Caldera** *JGR*
  Vanorio, T., et al
  2005; 110 (B03201)
- **The deep structure of the Larderello-Travale geothermal field from 3D microearthquake traveltime tomography** *GEOPHYSICAL RESEARCH LETTERS*
  Vanorio, T., De Matteis, R., Zollo, A., Batini, F., Fiordelisi, A., Ciulli, B.
  2004; 31 (7)
- **A new seismic tomography of Aigion area (Gulf of Corinth - Greece) from 1991 dataset** *Geophysical Journal International*
  La Torre, D., Virieux, J., Monfret, T., Montailler, V., Vanorio, T., Got, J., Lyon-Caen, H.
  2004; 159: 1013–1031
- **Elastic properties of dry clay mineral aggregates, suspensions and sandstones** *GEOPHYSICAL JOURNAL INTERNATIONAL*
  Vanorio, T., Prasad, M., Nur, A.
  2003; 155 (1): 319-326
- **Three-dimensional seismic images of the Larderello-Travale geothermal area-Italy from microseismic travel time data** *Geother. Res. Coun. Bull.*
  Vanorio, T., De Matteis, R., Zollo, A., Fiordelisi, A., Ciulli, B.
  2003
- **Ultrasonic velocity measurements in volcanic rocks: correlation with microtexture** *GEOPHYSICAL JOURNAL INTERNATIONAL*
  Vanorio, T., Prasad, M., Patella, D., Nur, A.

2002; 149 (1): 22-36

- **Evaluation of Porosity and Saturation Degree by Laboratory Joint Measurements of Velocity and Resistivity: a Model Improvement** *PAGEOPH*
  Carrara, E., Mazzacca, A., Roberti, N., Vanorio, T.
  1999; 154 (2): 211-255